

National Aeronautics and
Space Administration



The Flight Opportunities Program

2013 Next-Generation Suborbital Researchers Conference

Presented by:

Dr. Laguduva "LK" Kubendran,
Program Executive for
NASA Flight Opportunities Program

Ronald Young,
Program Manager for
NASA Flight Opportunities Program

June 5, 2013

www.nasa.gov/spacetech



The Flight Opportunities Charter



To facilitate maturation of cross-cutting space technologies for NASA's Space Technology [Mission Directorate] . . .

. . . while achieving a goal of the National Space Policy to “Encourage and Facilitate” the growth of the U.S. commercial space industry

Create the innovative new space technologies for our exploration, science, and economic future.

- NASA Strategic Goal 3

Energize competitive domestic industries

- National Space Policy Goal 1



Space Technology Portfolio



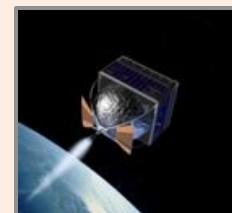
Transformative &
Crosscutting
Technology
Breakthroughs



**Game Changing
Development**



**Technology
Demonstration Missions**



**Small Spacecraft
Technologies**

Pioneering
Concepts/
Developing
Innovation
Community



**Space Technology
Research Grant**



**NASA Innovative
Advanced Concepts**



**Center Innovation
Fund**

Creating Markets &
Growing Innovation
Economy



**Centennial
Challenges Prize**



**Small Business Innovation Research
& Small Business Technology
Transfer (SBIR/STTR)**

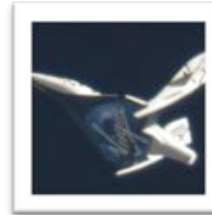


**Flight
Opportunities**

Current Flight Providers



Armadillo Aerospace
STIG



Virgin Galactic
SpaceShipTwo



Masten Space Systems
XA-0.1
"Xaero" / "Xombie"



Whittinghill Aerospace
mCLV-RSR



Near Space Corporation
High Altitude Balloon and Shuttle Systems
NBS, SBS, and HASS



XCOR Aerospace
Lynx



UP Aerospace
SpaceLoft XL



JSC RGO / Zero-G Corporation
"G-Force One"

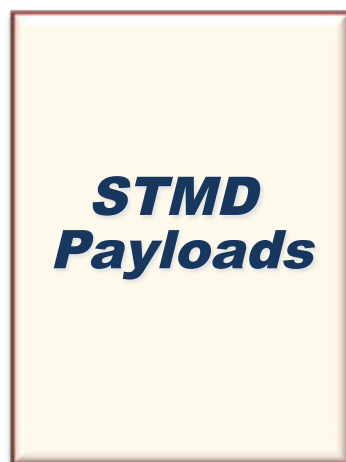
Enable Space Technology flight testing through the acquisition of **Commercial Suborbital Flight Services**



Pathways to Flight



Internal



***Flight
Opportunities***

External



*Announcement of Flight
Opportunities (AFOs)
NASA Res. Announcement*



*Other Mission Directorates
(e.g., ROSES, HOPE, HRP)*



Other Govt. Entities

*ROSES: Research Opportunities in Space and Earth Sciences; HOPE: Hands-on Project Experience;
HRP: Human Research Program*

Competed and Sponsored Paths Available



Payload Development and Vehicle Capability Enhancements



Flight Opportunities / Game Changing Development Program's NASA Research Announcements (NRA) : “Technology Development for Suborbital Flight Opportunities”

- Topic 1: Development of Space Technology Demonstration Payloads
(Remote Sensing Instruments, Observatories, and In-Situ Instruments: EDL Technology Demonstrations for Small Earth Return Vehicles)
- Topic 2: Vehicle Capability Enhancements and Onboard Research Facilities for Payload Accommodation
(Instrument Pointing, Tracking, and Stabilization Systems; Biological Facilities)
- Topic 3: Development of Small Spacecraft Propulsion Technology

Open Call: Proposals due June 17, 2013

Hosted on NASA NSPIRES



Participant Roles



Flight Opportunities Program

- Payload solicitation, selection and pipeline coordination
- Work with technology payload providers to develop mission requirements
- Serve as technical monitors for Flight Opportunities campaigns
- Track and report technology maturation and outcomes

Payload Providers

- Develop and deliver payloads
- Work with FSP on payload-vehicle integration and flight activities
- Work under guidance of the FOP Campaign Manager

Flight Service Providers

- Fly payloads as a commercial service
- Accept and integrate payloads and manage flight safety
- Coordinate with spaceport launch facilities
- Operate under FAA licensure, permits or waivers



Current Operating Principles



AFO: Solicitations for Flight Opportunities Program

- No funding to PI for payload development
- Select proposals with high technology relevance to future NASA missions
- Group payloads for flight campaigns as full manifests, as possible

IDIQ contracts for Payload Integration & Flight Services

- Vendors qualify vehicle capabilities to prescribed altitudes prior to bidding
- Competitive fixed-price bids for flights and payload integration services
- Improves utility of commercial sRLVs by buying frequent flights

NRA: Competitive Funding Opportunities

- Technology payload development
- Payload accommodation development on sRLVs



Future Operating Principles



IDIQ Flight Service Contracts

- Continue flying NASA sponsored payloads
- Purchase flights on a ‘per seat’ basis or full manifest, as warranted
- Allow greater flexibility to meet payload needs

NASA Research Announcements for Technology Demonstrations

- Use Cooperative Agreements and Space Act Agreements
- Provide funding and/or support to stimulate technology R&D
- Allow researchers to directly team and work with flight service providers
- Enable enhanced vehicle capability development to help meet payload requirements



Learning By Doing



Three Years Ago the Startup Goals Were:

- Be anchor customer for sRLVs
- Don't impose NASA requirements on commercial sRLV providers
- FSPs are ultimately responsible for payload and flight safety

Evolved Differently than we Thought

- Required stronger adherence to commercial operating principles
- Assumptions about schedule and vehicle capabilities were overly optimistic

Resolved Requirements Conflict Between NASA and Other Stakeholders (NASA technical, safety, Legal, contracts, ...)

Created Updated Vision for Flight Opportunities Program

- Become one of many customers
- Purchase flights and fund payload accommodation development
- FOP to step-back as commercial capabilities mature



National Aeronautics and
Space Administration



2013 and Beyond

NASA Flight Opportunities Program

Presented by:

Douglas "Dougal" MacLise,
Technology Manager for
NASA Flight Opportunities Program

Bruce Webbon,
Campaign Manager for
NASA Flight Opportunities Program

Christopher Baker
Campaign Manager for
NASA Flight Opportunities Program

June 5, 2013

www.nasa.gov/spacetech





Zero-G Parabolic & UP Aerospace sRLV Flights



Dougal Maclise

FOP Technology Manager

(for Paul DeLeon – Campaign Manager)

NASA Ames Research Center



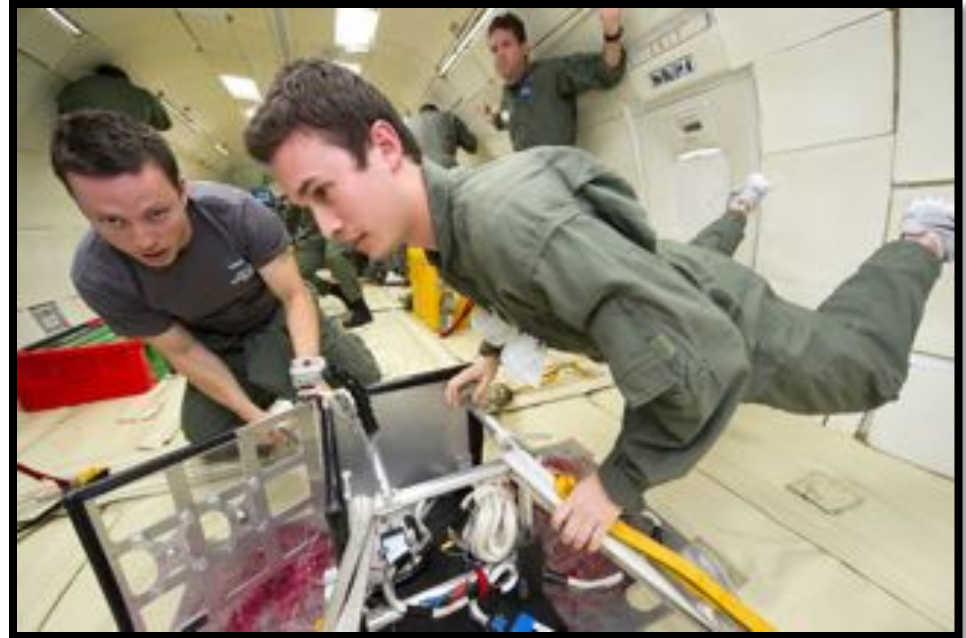
Reduced Gravity Flight Campaigns



Recent flight campaigns on Zero-G's 727 aircraft in conjunction with NASA JSC's Reduced Gravity Office in February and April 2013

Campaign currently occurring

Next campaign in July 2013



Ten technologies tested so far this year, 35 since 2011



Reduced Gravity Flight Campaigns





3D Printing in Microgravity



Gateway to fabricating parts on-demand in space.



"Made In Space credits much of its early innovation to the work performed through the Flight Opportunities Program... From this we developed a foundation for the development of our 3D Printer for the ISS."

Jason Dunn
Chief Technology Officer
Made In Space, Inc.

Three successful parabolic campaigns. Fourth underway this week.
Experimental 3D printer to be delivered to the ISS in 2014



NASA flights with UP Aerospace Space Loft XL



Thirteen technology demonstrators and experiments slated for flight in 2013

SL7 launch planned for June 21, 2013

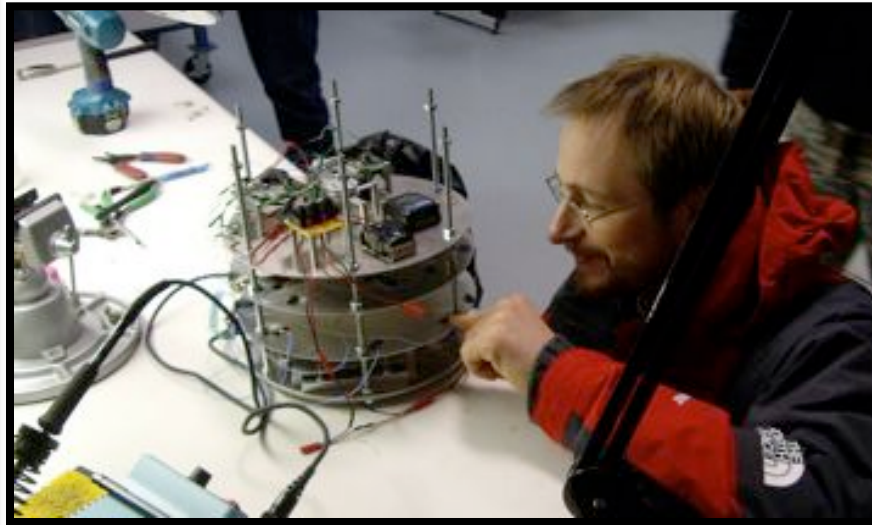
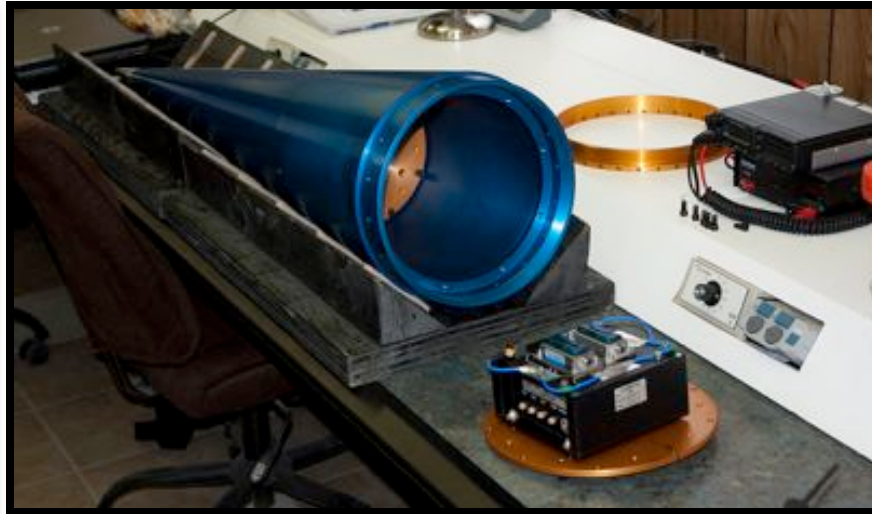
Six Technology demonstrators onboard including payloads from NASA, FAA, AFRL, industry and NMSSC

SL8 launch planned for October, 2013

Seven Technology demonstrators onboard



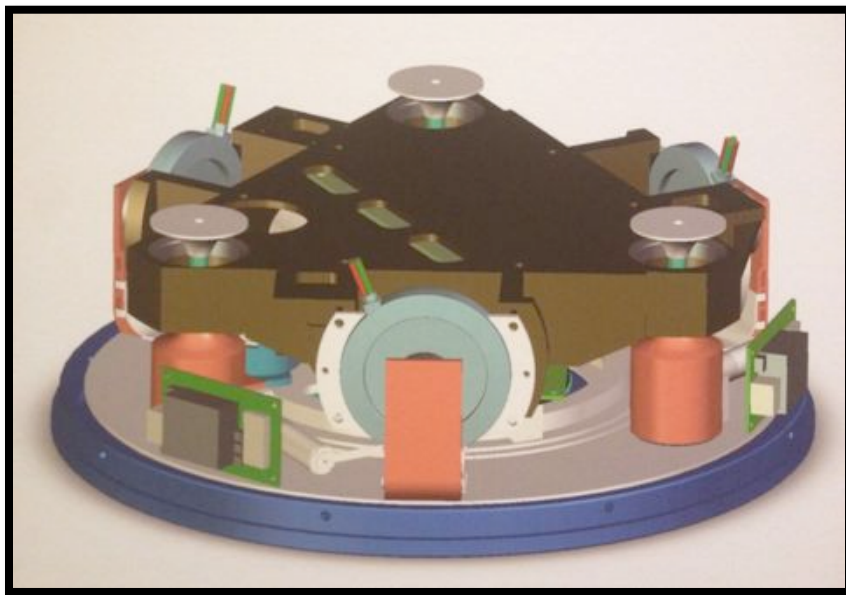
NASA flights with UP Aerospace Space Loft XL



Microgravity Vibration Isolation Platform



Isolation system to increase microgravity quality for attached sRLV payloads



Caged free floating system under development (NRA) by Controlled Dynamics in conjunction with UP Aerospace

CDI accelerometer sensor payload will characterize SL7 vibration environment (flight June 21, 2013). Spectra vibration data will be used to drive Vibration Isolation (damper) Platform on SL-8 flight



Zero-G Parabolic & UP Aerospace sRLV Flights



Thoughts and Questions



Balloon & High Altitude Shuttle System Flights



Bruce Webbon
FOP Campaign Manager
NASA Ames Research Center



High Altitude Balloon Flights



Flights of Near Space high altitude balloon systems in January and February of 2013

NMT Structural Health Monitoring

FAA / ERAU Automatic Dependent Surveillance-Broadcast (ADS-B)



Currently working on additional balloon flights for 2013 including drop tests of experimental vehicle landing systems and observation instruments



Balloon Platform Coarse Pointing System



Program is funding Near Space Corp. to develop a capability for instrument development enabling continuous target observation



Payload accommodation of coarse pointing / stabilization system for observational instruments on NSC Balloon Systems

First flight planned for September 2013

Second flight is planned for November 2013 with SwRI star tracker payload

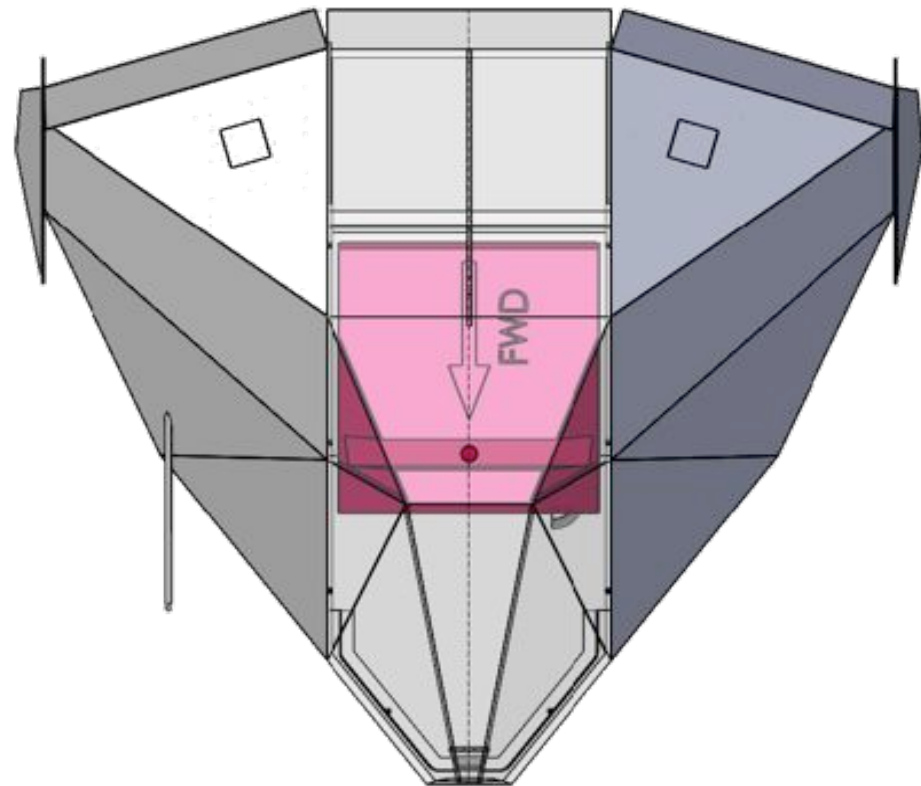


NSC High Altitude Shuttle System (HASS)

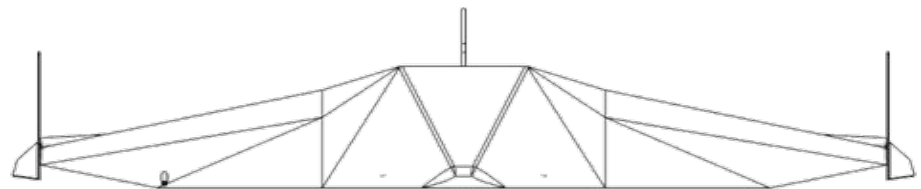


Payload Bay Dimensions
 $\approx 19 \times 20 \times 5$ in

Payload Mass
< 22 lbs



Reference:
NSC High Altitude Shuttle System
Payload User's Guide (Rev A)

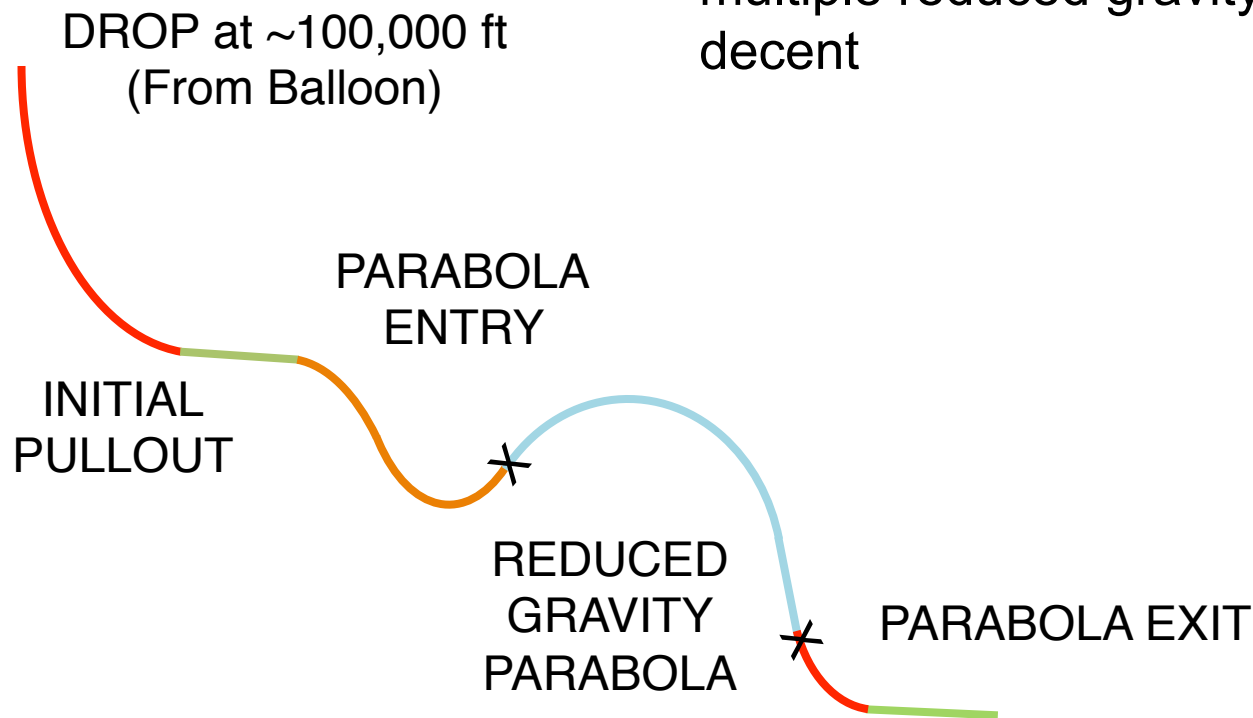




HASS Parabolic Flight Profile



Purdue University collaborating with NSC to develop and test capability to perform multiple reduced gravity parabolas during decent





Balloon & High Altitude Shuttle System Flights



Thoughts and Questions



Emerging Suborbital Reusable Launch Vehicles



Christopher Baker
FOP Campaign Manager
Dryden Flight Research Center

Guidance Embedded Navigator Integration Environment (GENIE)



Capability to test new sensors for landing on extra-terrestrial bodies



"We believe the GENIE and Xombie system provide NASA with the platform necessary to demonstrate a wide range of exciting planetary landing technologies including advanced guidance technology."

Doug Zimpfer

Associate Director for Human Space Exploration

Charles Stark Draper Laboratory

Successful envelope expansion of Masten's XA-0.1B "Xombie" controlled by Draper Laboratory's GENIE system in March



Guidance for Fuel-Optimal Large-Divert (G-FOLD)



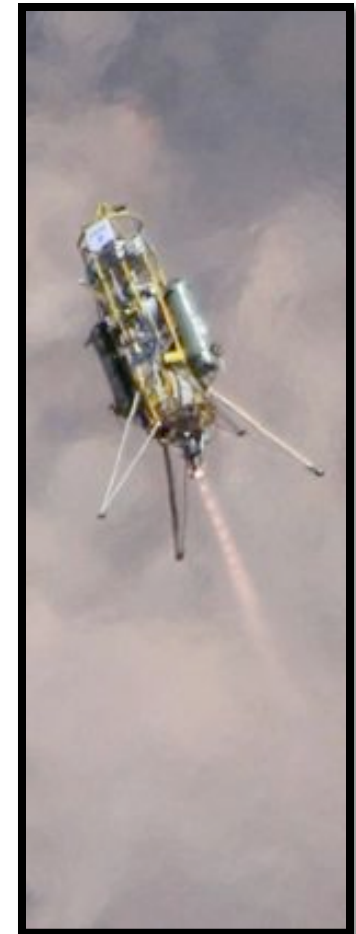
Real-time course correction for planetary pinpoint landing

G-FOLD computes fuel optimal trajectories for large divert landing maneuvers

“The current capability to deliver payloads to the surface of Mars within a small landing ellipse is inadequate for future mission needs.”

NASA Strategic Space Technology Investment Plan

2013 development and flight activity (NRA) continues
successful 2012 JPL flights with Masten





SpaceShipTwo Research Flights



Virgin Galactic is preparing for Flight Opportunities research campaign in mid-2014

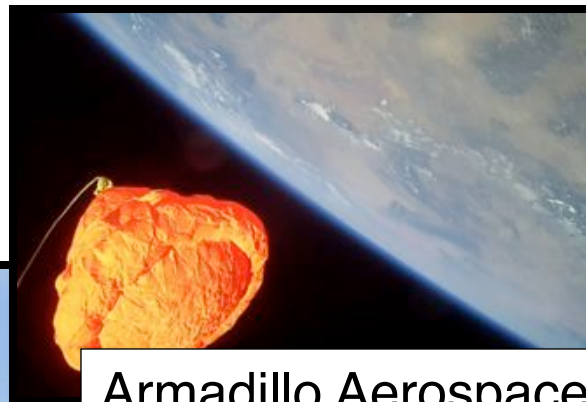




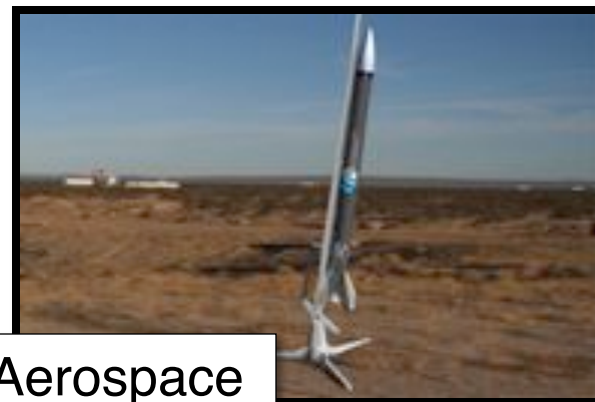
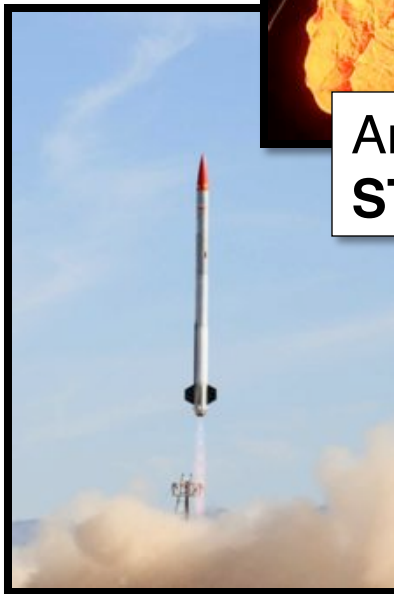
Emerging sRLVs



XCOR Aerospace
Lynx



Armadillo Aerospace
STIG



Whittinghill Aerospace
mCLV-RSR



Emerging Suborbital Reusable Launch Vehicles



Thoughts and Questions

